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ABSTRACT

While it is financially impossible to design a whole spectrum of preparatory chemistry courses to suit the varying backgrounds and needs of students entering an open-door institution, chemistry courses can be designed to meet three instructional needs shared by all students: mutual respect between the instructor and the students; implementation of methods to achieve realistic course objectives; and basic skills remediation. Instructors can foster good relations with students by balancing criticism with praise and striving to bolster students' self-esteem through patient encouragement. Instructors should avoid the temptation to cover all chemistry topics and should use individualized, non-threatening instructional methods to achieve realistic course goals. Such methods include informing students of specific learning objectives, encouraging them to organize materials by preparing a "legalized crib sheet" for use during exams, and providing for retesting on the sections of an exam with which students had trouble. Grade consciousness should be further diminished by convincing students of the importance of studying chemistry in today's world. Finally, remediation efforts should be centered around improving reading speed, reading comprehension, study habits, and mathematical skills. To assist in these efforts, instructors should direct students to remediation experts and emphasize a quantitative approach to laboratory exercises to apply math skills. (JP)

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A PHILOSOPHY FOR TEACHING PREPARATORY CHEMISTRY.

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A Philosophy for Teaching Preparatory Chemistry

The construction of an effective preparatory course in chemistry presents us with a formidable set of problems. Specifically, how do we go about doing the job in keeping with the high standards that ought to characterize college education while the open-door policies (which I endorse) typical of state and community colleges presents us with a mind-boggling variety of student types and backgrounds? Obviously, we cannot have separate courses for veterans, repeaters, career-changers, and the temporarily jobless. The financial restrictions on the proliferation of courses also precludes the variety of preparatory courses we might like for those ethnic and racial minorities who are described as economically and socially underpriviledged. And one might wonder about those students who had no high school chemistry or if they have an experience, it is remembered as a dismal encounter.

It seems to me that our primary job in this area of preparatory chemistry is to identify those needs that are common to the whole spectrum of student types. This may be an impossible objective, but no one has ever suggested easy solutions. If may be that we are dealing with a problem for which there is no solution, but rather we will have to be content with a steady evolution from bad to better.

The preparatory chemistry philosophy as I envision it and try to implement it can be described in three parts: A mutual respect between instructor and students, the remediation of basic skills,

and realistic expectations in terms of course content.

RESPECT:

Assuming that we are humane beings (if not amateur psychologists), it would seem to me that we ought to be concerned with some self-image building or damaged-ego repair for many of our students who come in with a feeling of hopelessness and little or no self-esteem. After all, we can't do much with students who tend to give up before they start. With an attitude toward our students that encompasses gentleness, humor, and an insistence on their intrinsic worth and human dignity we can generate the optimal climate for learning. We need to balance criticism with praise when possible. We should encourage and reassure with unflagging patience. And we need to be accessible to students who would come to us for help and understanding.

REALISM:

We need to re-evaluate our objectives periodically so that we can distinguish between the ideal and the realistic. We should constantly remind ourselves whom we are teaching and what we are preparing them for. Realistic goals probably lie somewhere between the extremes of high standards (flunk 'em if they can't hack it) and the dispensation of an oversimplified pablum that is not quite honestly called "college chemistry". A partial answer might be found in the use of individualized and self-paced programs.

My own approach has been effective to such an extent that I would like to share it with you. The students are provided with a list of learning objectives so that they know what is expected of them in terms of content mastery in a chapter. Questions and problems are assigned as a loosely constructed pre-test. Then all students take an exam at an announced time.

While the exam is not open-book, the students are permitted to bring a 5" x 7" card to the exam on which they have written any information they deem essential. The advantage of the legalized "crib-sheet" is that it forces the students to study, organize, and identify gaps in their understanding of concepts and capability to solve problems. I've found that open-book exams, by contrast, encourage poor preparation and a frantic riffling of pages in an effort to find answers that are usually not there.

On the basis of their individual results, the students can identify their specific problems and remedy them by additional study. When the student has achieved a more solid mastery, he or she can arrange a re-test and demonstrate their improvement. The re-test opportunity has been a tremendously positive force in student learning. It makes the exam more truly a learning instrument as opposed to a mere grading device. The slower learner is not penalized in this way. I call this repetetive process "calculated redundancy."

In order to make the re-test a less time-consuming operation, I require the students to retake only those problem types that need improvement. Hence, a student who scores 80% may need to take only two problems of a type that were incorrectly done in the first exam.

The enormous improvement often shown by students on the re-test is gratifying to them and their teacher. I think we can teach a lot more chemistry outside the shadow of the guillotine. If we diminish tension, and the grim, humorless preoccupation the student tends to have toward grades, we are taking a giant step in the direction of humanizing our craft.

Grade consciousness can be diminished further, if we can justify to the students why they should expose themselves to the rigors of a particular scientific discipline. Most importantly, our rationale must include reasons quite apart from the practical necessity of science courses for students pointing toward a career in a science related profession. Pragmatic justification is really sine qua non, but justification in terms of moral and cultural values is the challenge to our imaginations.

One reason is that students, as citizens, have a responsibility to become literate in science. It is a concern for truth and accuracy (if not self-preservation) to be able to evaluate critically the claims made by scientific industries in popular magazines and newspapers. Perhaps, more importantly, scientific literacy can help our citizens cope with the exalted status of science often granted by people who have only a vague notion of what constitutes

scientific activity. We need to learn about the historical forces at work in the theoretical-experimental interplay that led, and still leads us today, to meaningful scientific constructions. Structures that are aesthetically pleasing and useful to mankind. Structures that are unique insofar as much of the beauty inherent in them lie in their tentative nature -- an amalgamation of hypotheses, theories, physical laws and bold assumptions. In effect, scientific literacy, in addition to providing the knowledge to make sensible decisions in the area of commerce and government, may enable us to distinguish between science and scientism.

Preparatory chemistry programs must be selective, necessarily. Even general freshman chemistry often smacks of being unrealistic when it attempts to cover the whole spectrum of topics commonly associated with general chemistry. Furthermore, we should constantly strive to weave-in anecdotal events from "real life" in an effort to help students conceptualize that which may be abstract in terms of their own limited experiences. If our experimental anecdotes and demonstrations are "relevant", so much the better.

REMEDIATION:

There seem to be four outstanding areas of need for the remediation of basic skills: reading speed, reading comprehension, study habits, and mathematics. We have all seen examples of students reading at a junior high (or lower) level. They read slowly and comprehend with difficulty. The fact that they also must read and re-read for a number of hours that far exceeds our expectations creates a demoralizing condition -- if not a nearly impossible hurdle for them to leap.

Students who read chemistry problems and fail to identify clearly what they are trying to solve and who are unable to organize the data available need help desparately.

Our college has a Learning Center equipped with the hardware and software designed to help these students. It is staffed with specialists in the field of reading and study. And we direct our students to these specialists. Periodically, free short courses in reading and study are provided and they are advertised. It seems to me that this is the only reasonable way to handle the problem. As long as we maintain an open-door admissions policy, the availability of reading and study specialists and programs are essential for students prior to, or concurrent with, preparatory courses. This not a redundant operation although it may seem to be so.

Remedial work in mathematics requires patience and reinforcement. The "new math" is an easy scapegoat when we choose to envision it as it was in its early days. But the "new math" is changing toward a more practical oreintation and we should agreeably move toward a fuller cooperation with mathematics teachers. We cannot, and should not, expect them to function as servants to the sciences. Mathematics teachers are starting to realize, as Keith Laidler (University of Ottawa) says, that "Mathematics may be the Queen of the Sciences, but she should be prepared to mingle with her subjects."

In our effort to bridge the gap between pure and applied math, our remedial work could profitably concentrate on percentage calculations, graph construction and interpretation, basic algebraic operations, dimensional analysis, scientific notation, and the proper use of significant figures. I would suggest further that we emphasize the quantitative aspects of our laboratory exercises so that numerical data are constantly moved from the realm of the abstract to the concrete.

There is no magic method and there are no perfect tools. But if we are realistic and if we care, each of us operating in an environment of mutual respect, we can do the job. While we may not be preparing many or most of our students to be scientists, we can communicate an enthusiasm for intellectual pursuit, increase their scientific literacy, and pique their latent curiosity.

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